NOVEMBER 2019

WIM #46
CSAH 1,
MP 11.4
WEST
CONCORD, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #46 is located on CSAH 1 near West Concord in Dodge county.

System Operation

WIM #46 was operational for the entire month of November 2019. Volume was computed using all monthly data.

System Calibration

WIM #46 was most recently calibrated on 2015-06-16. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 12077 | Passenger Vehicles: 8708 | Heavy Commercial Vehicles: 3369

Monthly Average Daily Traffic (MADT): 411 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 112

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Saturdays, with lowest volumes reported on Mondays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 06 AM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 06 AM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 3369 HCVs, 1231 of them were overweight [3]. These overweight HCVs contributed to 11.9% of total monthly volume, and 42% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Thursdays. SB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Saturdays. See Figure 3 .
The top two overweight violators by class were the class 9 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 59.3% of all overweight vehicles traveling SB this month (see Figure 7 & 8).
Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in November.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,354 NB vehicles exceeded 88,000 pounds (290 vehicles were Class 9's; 52 vehicles were Class 13's). Of vehicles traveling SB,

334 NB vehicles exceeded 88,000 pounds (308 vehicles were Class 9's; 12 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from November 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in November 2019. Data suggests that there were greater numbers of empty Class 9's than fully_loaded Class 9's traveling NB, while there were more fully_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more empty class 10 vehicles.

Freight Totals. A total of 39684 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (55.5%) than NB (44.5%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 91587 (a precast pipe arch) is approximately 4.2 miles south of WIM #46. Bridge No. 91588 (a precast pipe arch) is approximately 7.8 miles south of WIM #46. WIM #46 recorded a total of 12077 vehicles with a combined GVW of 208892 kips (1 kip = 1,000 pounds = 0.5 tons) in November 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 7155 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 67.7% of all ESALs were recorded SB while 32.3% was observed NB. In particular, 59% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 62% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

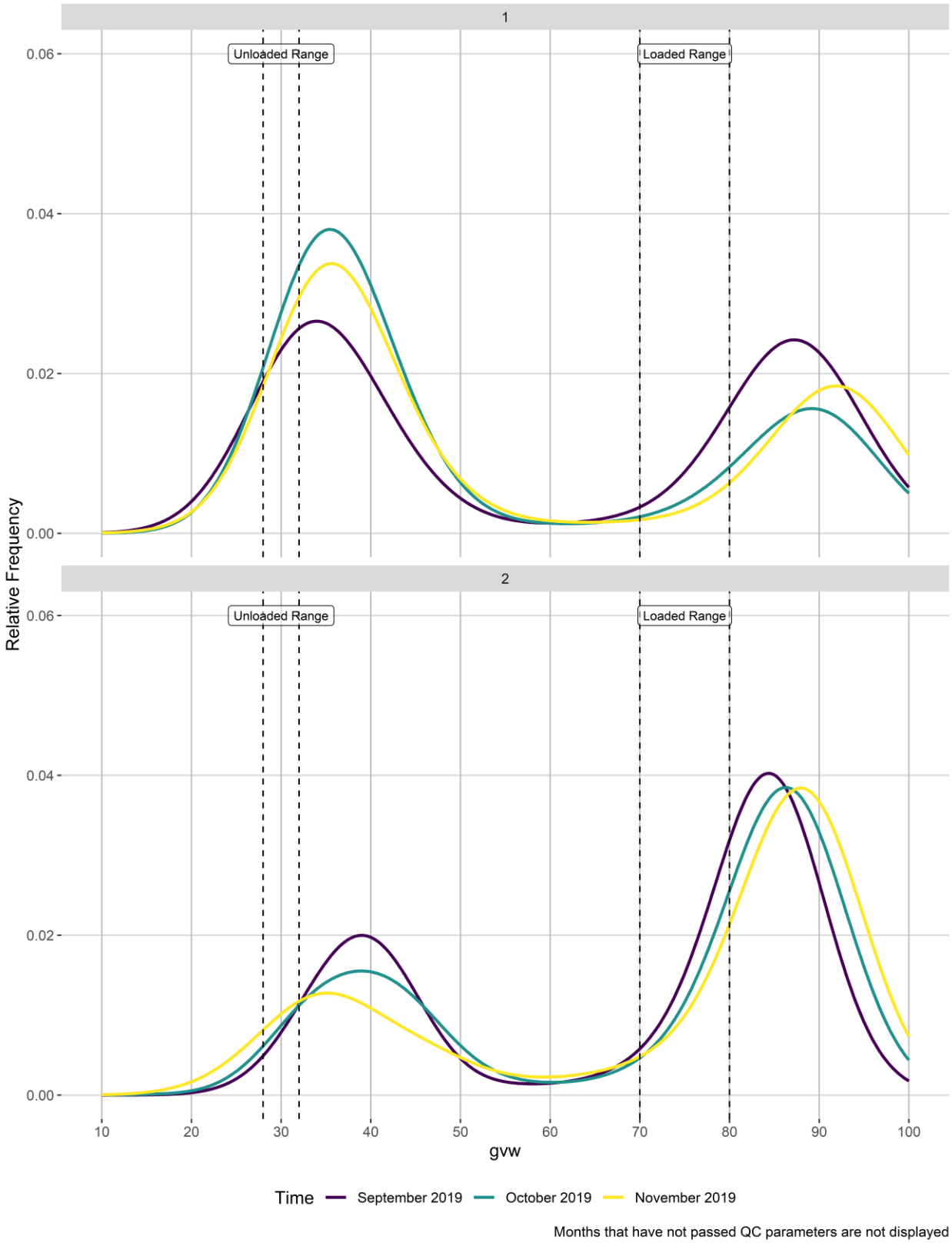
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

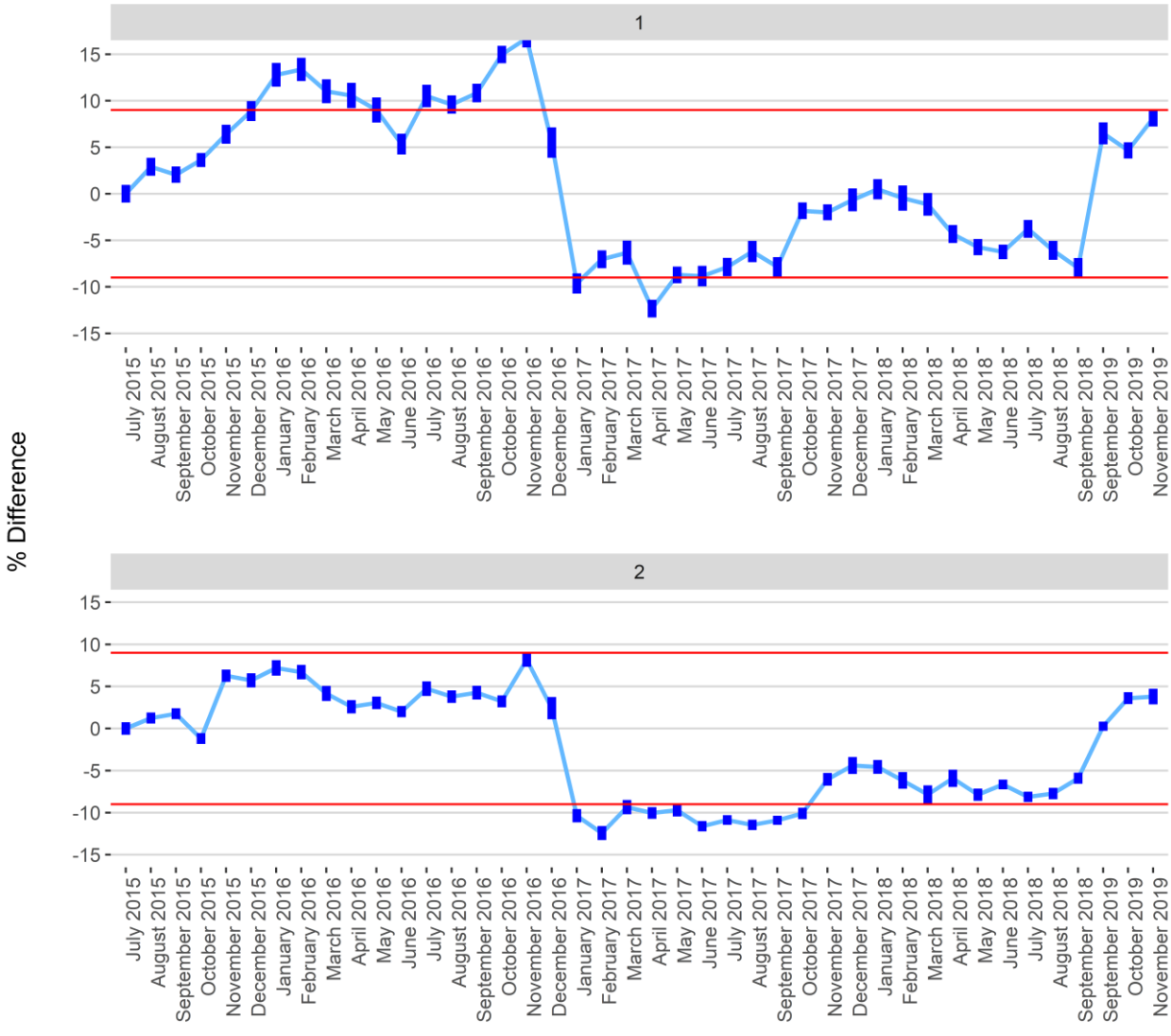
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

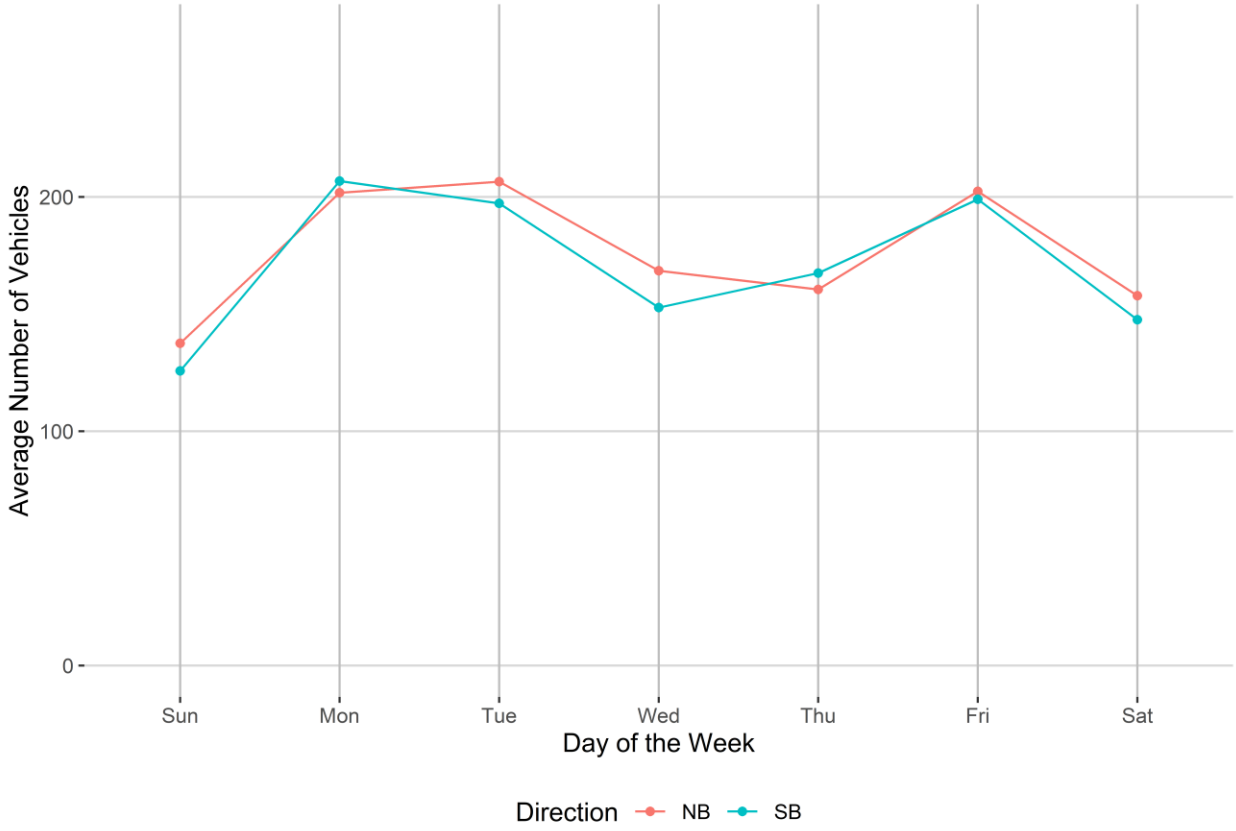


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

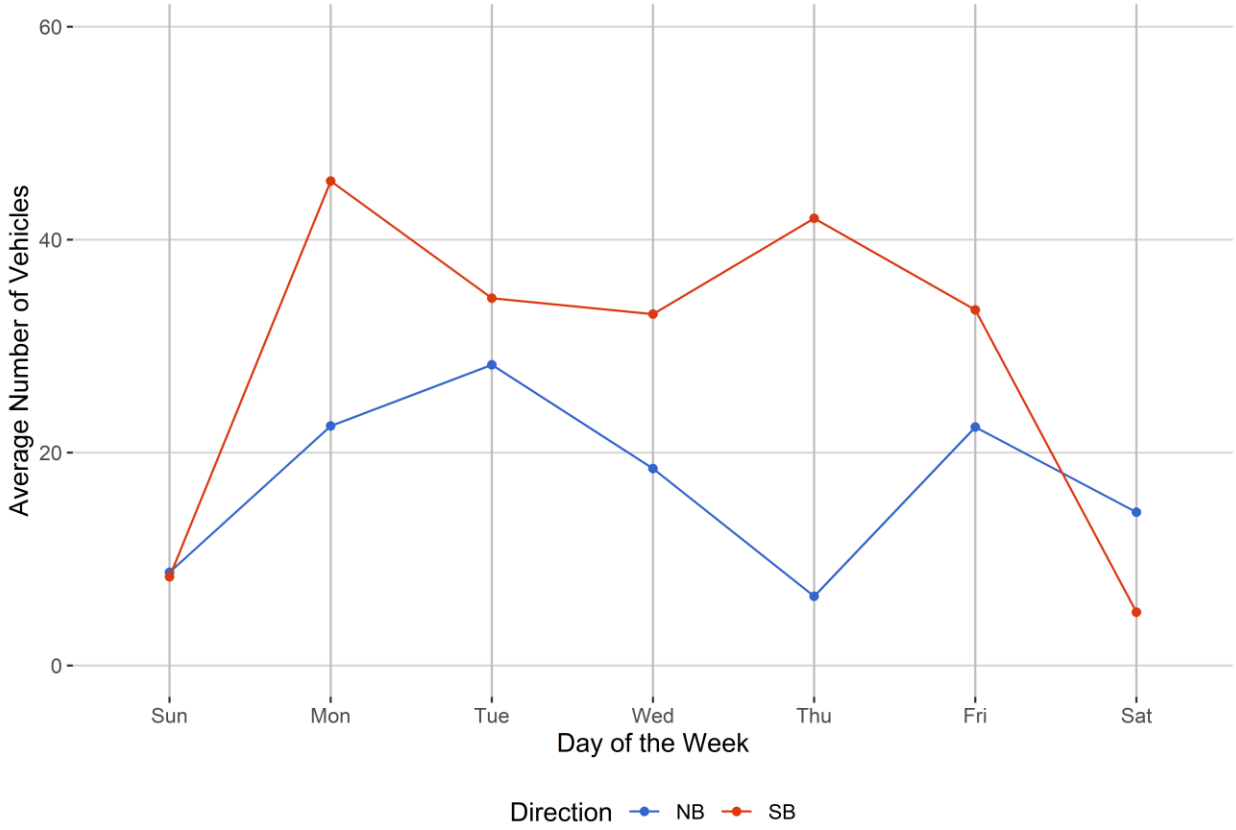


Figure 4 - Passenger Vehicles
vs. Hour of the Day

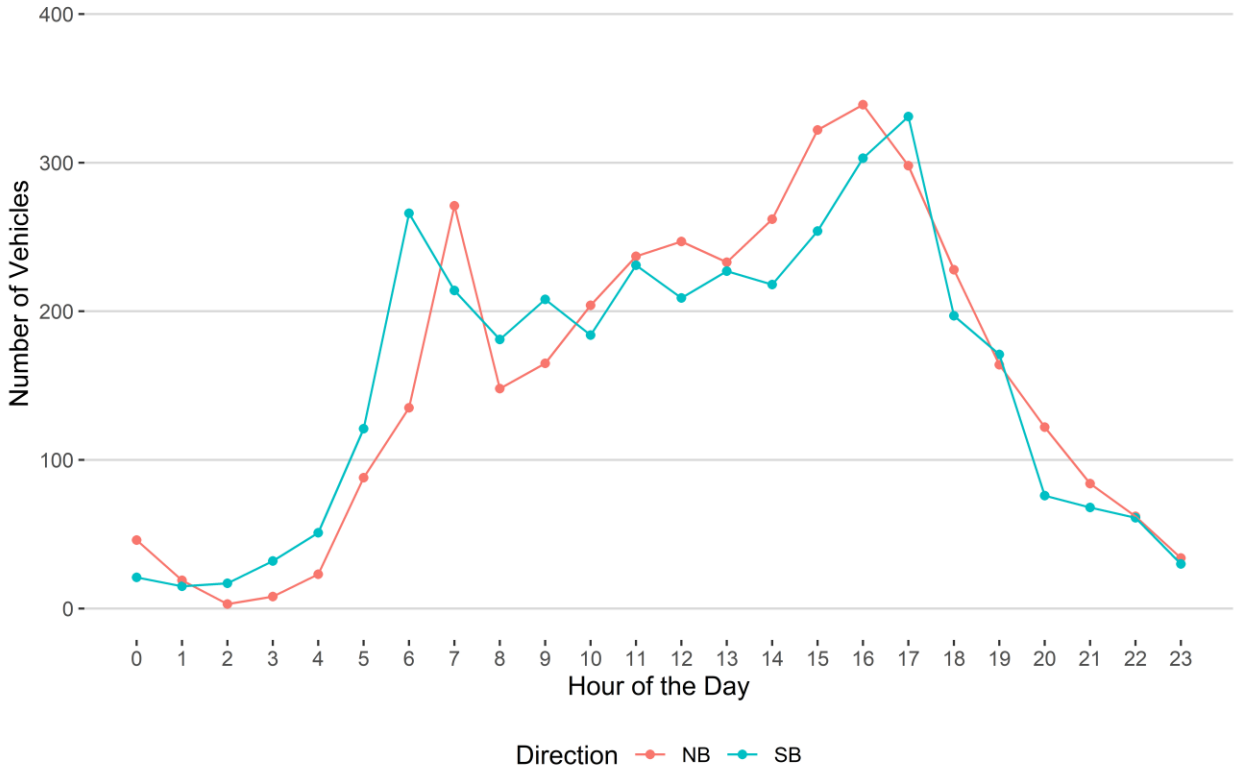


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

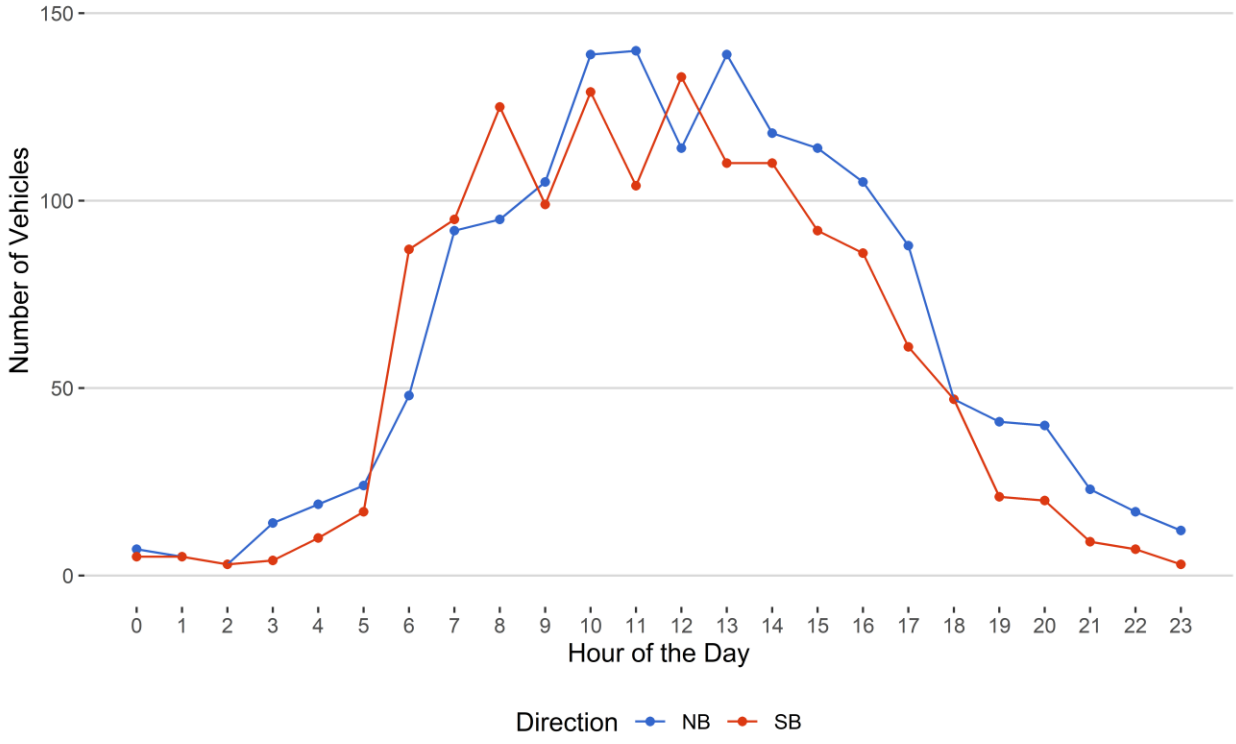


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

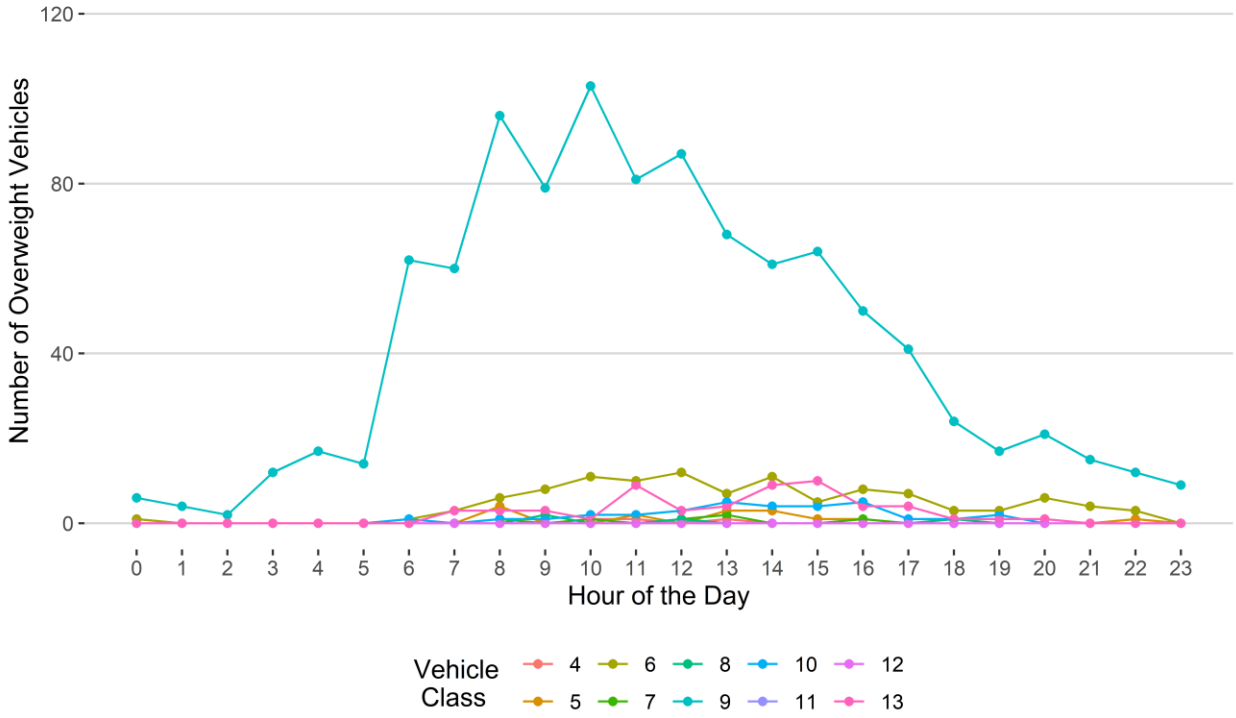


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

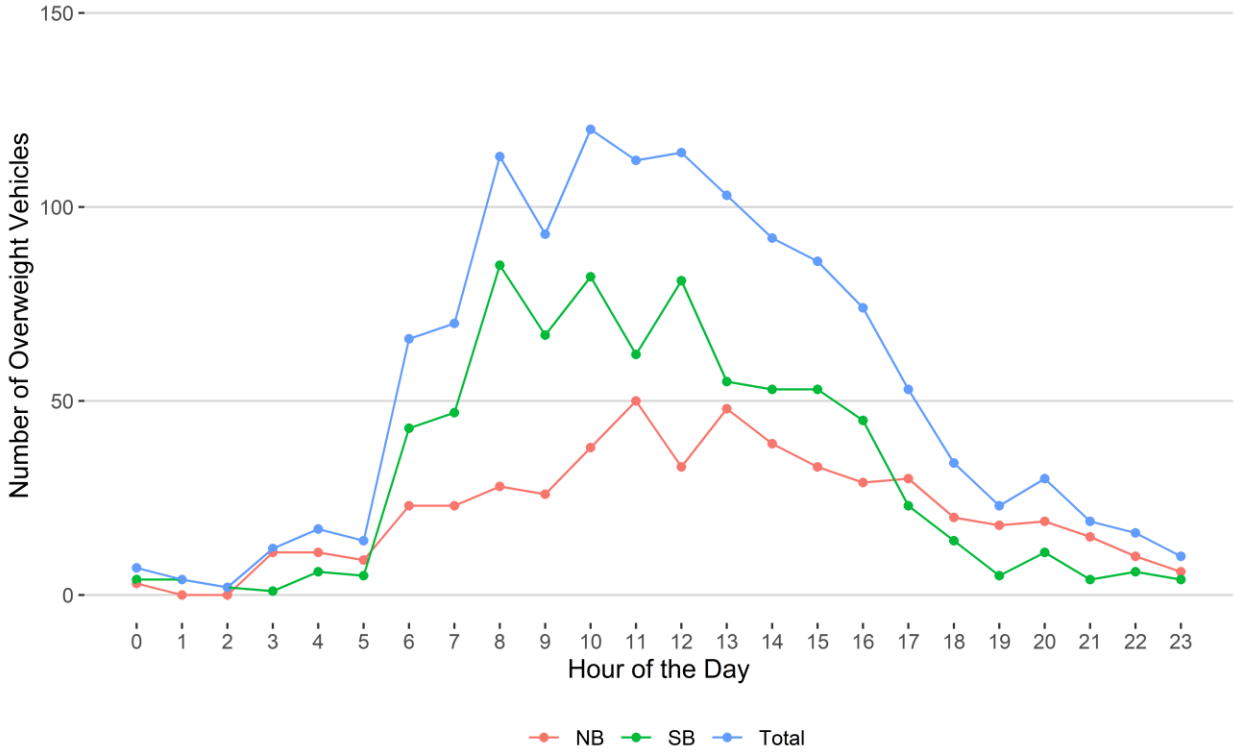
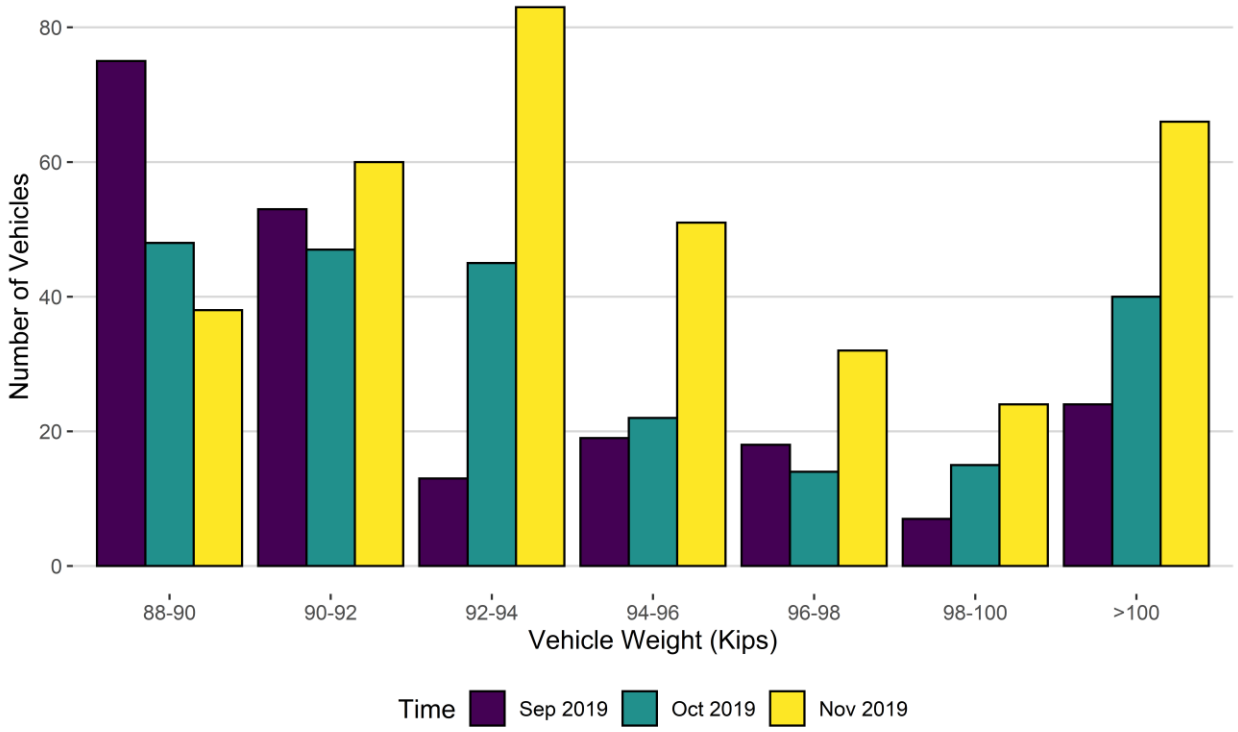
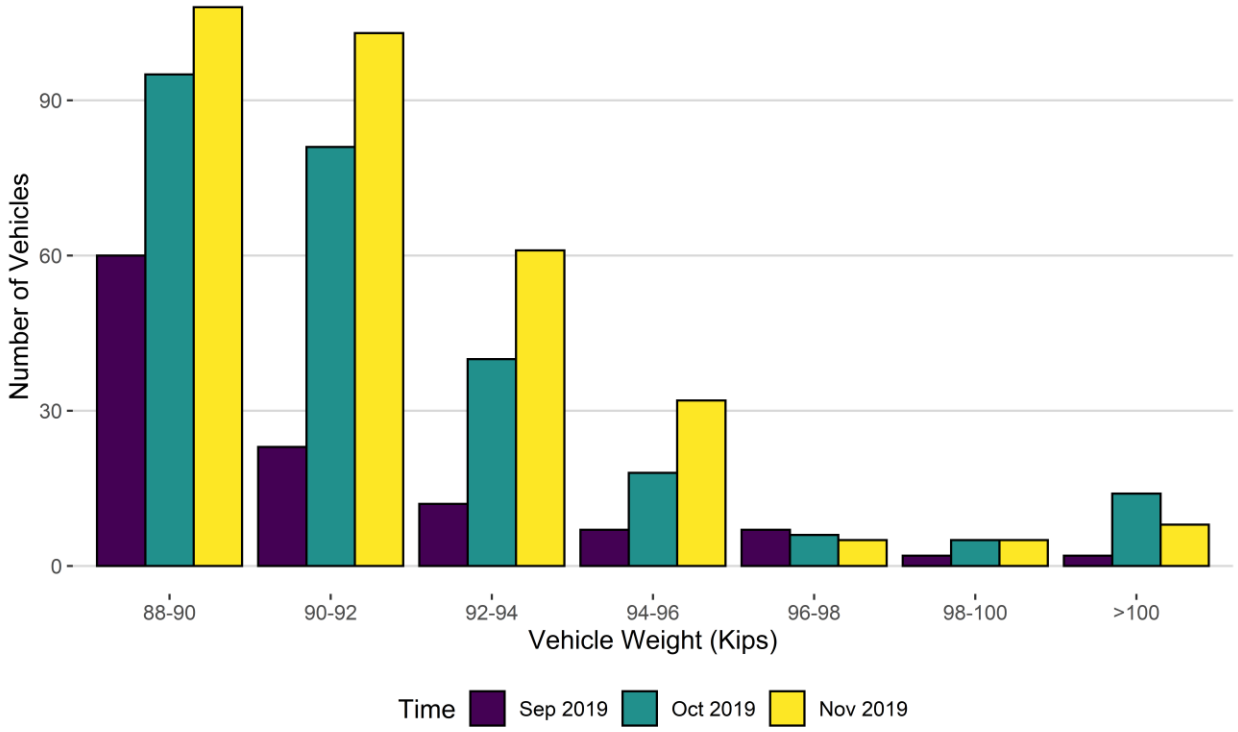


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2019*	*Oct 2019*	*Nov 2019*
88-90	75	48	38
90-92	53	47	60
92-94	13	45	83
94-96	19	22	51
96-98	18	14	32
98-100	7	15	24
>100	24	40	66
Total	209	231	354

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Sep 2019*	*Oct 2019*	*Nov 2019*
88-90	60	95	108
90-92	23	81	103
92-94	12	40	61
94-96	7	18	32
96-98	7	6	5
98-100	2	5	5
>100	2	14	8
Total	113	259	322

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

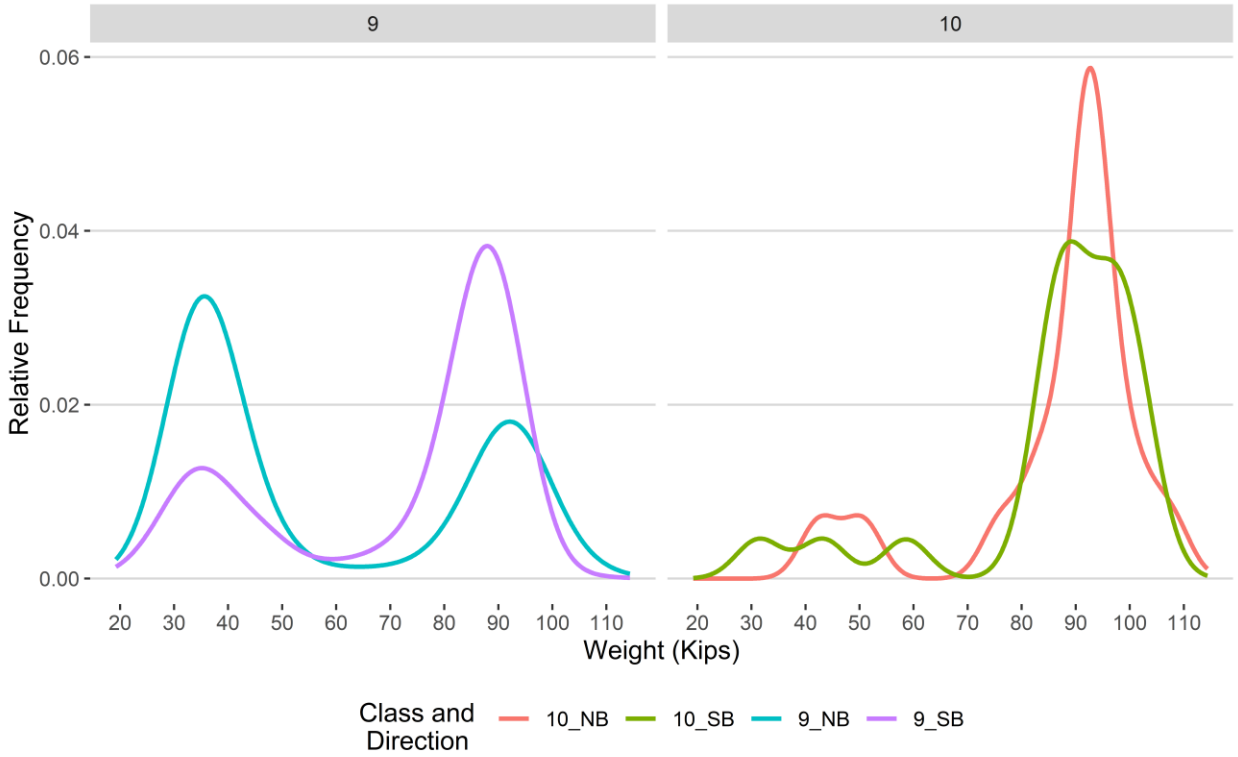


Figure 9 - Freight Percentage by Direction and Class

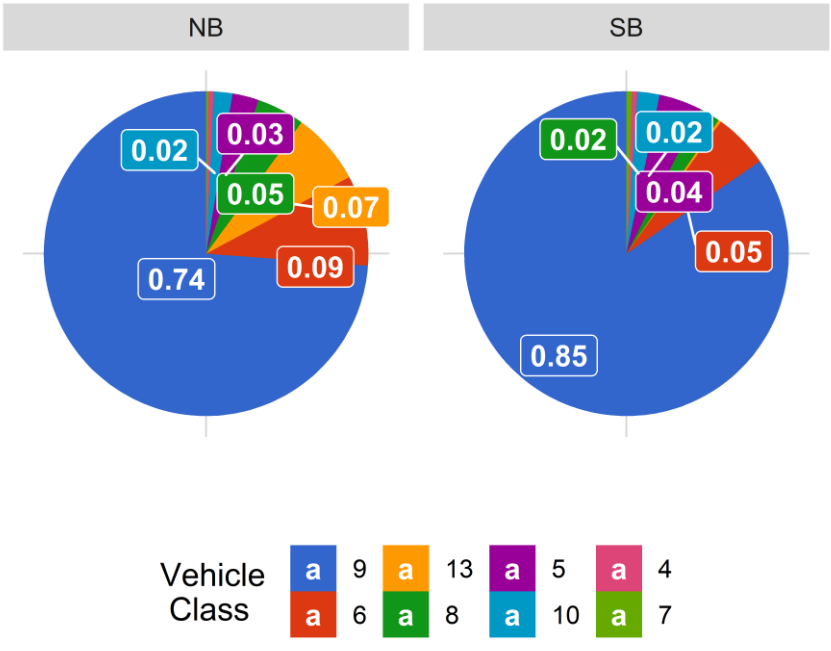


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

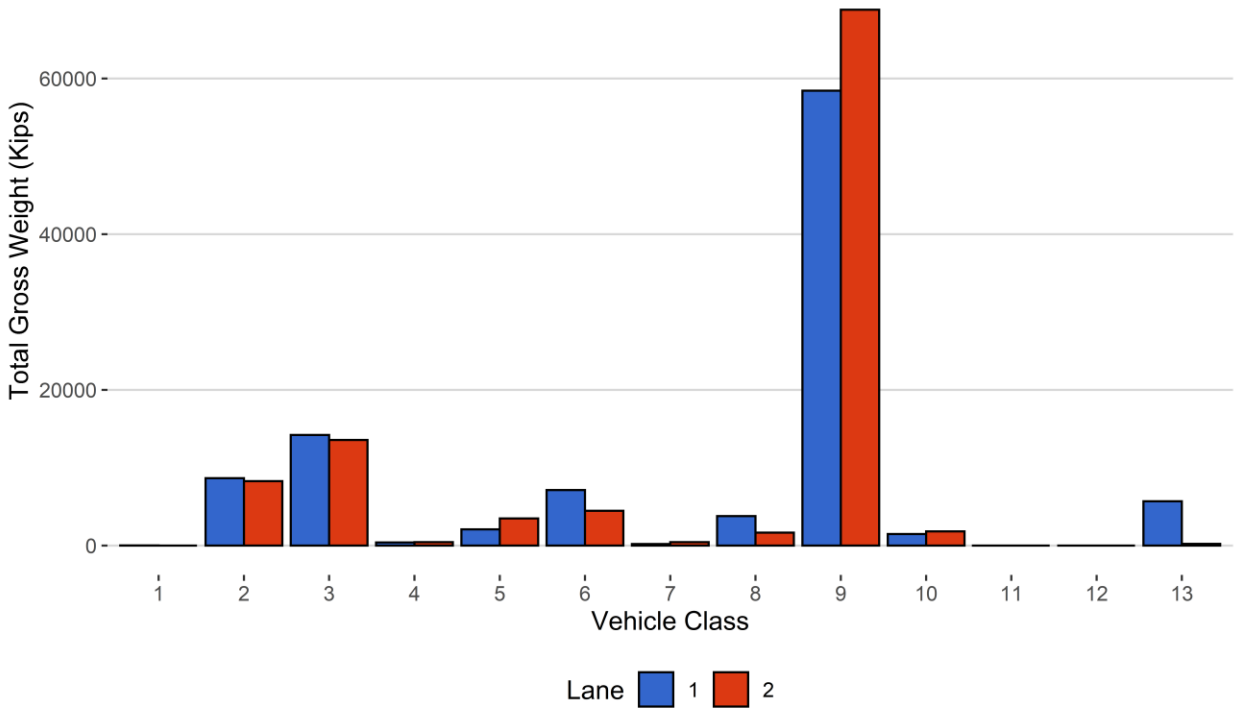


Figure 11 - Total Gross Vehicle Weight

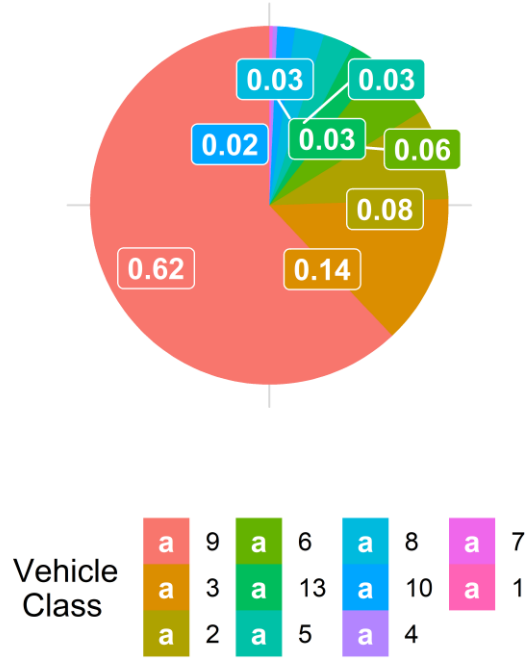


Figure 12 - Total ESALs by Class and Lane

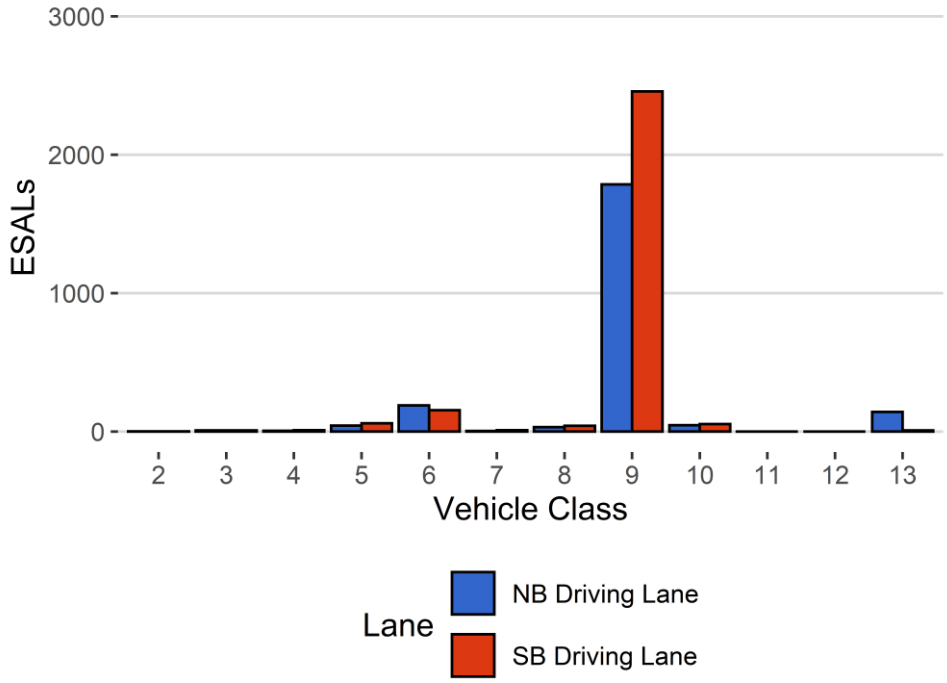


Figure 13 - ESALs by Class

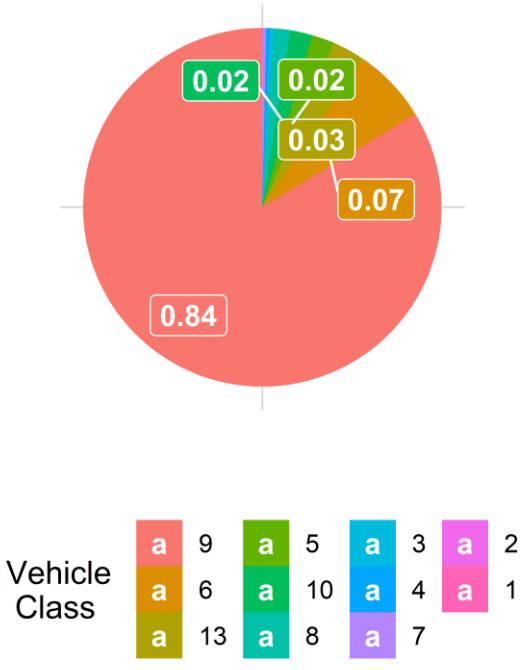


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
July 2015	10.71	0.00	11.00	0.00
August 2015	11.02	2.90	11.14	1.24
September 2015	10.93	2.05	11.19	1.76
October 2015	11.10	3.63	10.87	-1.20
November 2015	11.40	6.40	11.69	6.28
December 2015	11.67	8.89	11.63	5.72
January 2016	12.08	12.78	11.79	7.19
February 2016	12.15	13.37	11.74	6.70
March 2016	11.89	11.02	11.46	4.16
April 2016	11.85	10.57	11.29	2.58
May 2016	11.68	9.01	11.34	3.04
June 2016	11.29	5.34	11.22	2.00
July 2016	11.84	10.51	11.52	4.73
August 2016	11.74	9.59	11.42	3.78
September 2016	11.87	10.83	11.47	4.25
October 2016	12.32	14.97	11.36	3.22
November 2016	12.50	16.72	11.90	8.19
December 2016	11.30	5.50	11.27	2.41
January 2017	9.68	-9.64	9.86	-10.37
February 2017	9.96	-7.04	9.63	-12.43
March 2017	10.04	-6.33	9.97	-9.35
April 2017	9.39	-12.35	9.90	-10.04
May 2017	9.78	-8.72	9.93	-9.71
June 2017	9.77	-8.85	9.72	-11.62
July 2017	9.87	-7.87	9.80	-10.88
August 2017	10.05	-6.21	9.74	-11.45
September 2017	9.87	-7.84	9.80	-10.91
October 2017	10.52	-1.83	9.89	-10.10
November 2017	10.50	-1.99	10.34	-6.05
December 2017	10.64	-0.66	10.52	-4.40
January 2018	10.77	0.49	10.50	-4.57
February 2018	10.66	-0.46	10.32	-6.18
March 2018	10.59	-1.13	10.14	-7.85
April 2018	10.25	-4.32	10.35	-5.93
May 2018	10.10	-5.73	10.14	-7.87
June 2018	10.04	-6.25	10.27	-6.66
July 2018	10.31	-3.77	10.11	-8.12
August 2018	10.06	-6.08	10.15	-7.73
September 2018	9.86	-7.97	10.35	-5.92

September 2019	11.41	6.50	11.03	0.27
October 2019	11.21	4.66	11.40	3.60
November 2019	11.58	8.13	11.42	3.79

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	0	3	0	0	0
2	150	4492	37.2	0	0
3	140	4213	34.9	0	0
4	1	36	0.3	3	0.2
5	15	436	3.6	16	1.3
6	11	330	2.7	109	8.9
7	0	14	0.1	6	0.5
8	6	184	1.5	4	0.3
9	75	2261	18.7	1005	81.6
10	1	44	0.4	32	2.6
11	0	0	0	0	0
12	0	0	0	0	0
13	2	66	0.5	56	4.5
TOTAL	**403**	**12077**	**100**	**1231**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-11-21	Thursday	23:18:59	9	NB	1	115.57
2019-11-11	Monday	06:52:15	9	NB	1	114.36
2019-11-10	Sunday	07:13:51	10	NB	1	110.54
2019-11-05	Tuesday	10:15:57	9	NB	1	109.24
2019-11-01	Friday	08:43:47	9	SB	2	109.19
2019-11-11	Monday	04:39:13	9	NB	1	109.07
2019-11-11	Monday	06:01:33	9	NB	1	108.73
2019-11-29	Friday	18:25:35	10	NB	1	107.64
2019-11-11	Monday	07:35:11	9	NB	1	106.02
2019-11-25	Monday	15:36:41	9	NB	1	105.93

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	NB	15	16	2	12.5	369	28	79
5	NB	8	140	0	0	2082	0	481
6	NB	19	183	1	0.5	7099	19	1820
7	NB	11.5	4	0	0	190	0	72
8	NB	31	117	33	28.2	3017	766	207
9	NB	33	1017	121	11.9	54702	3743	12567
10	NB	33.5	17	0	0	1478	0	454
13	NB	31.5	55	0	0	5684	0	1976
TOTAL	****	****	**1549**	**157**	****	**74621**	****	**17656**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	SB	15	15	2	13.3	399	28	102
5	SB	8	239	11	4.6	3403	82	789
6	SB	19	104	1	1	4439	16	1241
7	SB	11.5	8	0	0	438	0	173
8	SB	31	43	9	20.9	1474	184	210
9	SB	33	950	79	8.3	66507	2333	18882
10	SB	33.5	21	1	4.8	1775	31	552
13	SB	31.5	2	0	0	218	0	77
TOTAL	****	****	**1382**	**103**	****	**78653**	****	**22028**
GRAND TOTAL	****	****	**2931**	**260**	**106**	**153274**	**7230**	**39684**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*
1	2	0	2	0
2	8659	8261	16920	8.2
3	14202	13558	27760	13.5
4	397	427	824	0.4
5	2082	3485	5567	2.7
6	7117	4456	11573	5.6
7	190	438	628	0.3
8	3783	1658	5441	2.7
9	58444	68840	127284	62
10	1478	1806	3284	1.6
13	5684	218	5902	2.9
TOTAL	**102040**	**103147**	**205187**	**100**
GVW/LANE	**49.73**	**50.27**	**100**	**0.05**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.25
2	1	1	3	0	0.002
3	10	9	18	0.4	0.0109
4	6	10	17	0.3	1.08
5	44	60	104	2	0.56
6	189	154	344	6.8	2.39
7	5	10	15	0.3	1.96
8	32	43	75	1.5	0.95
9	1786	2457	4243	83.7	4.34
10	46	55	100	2	4.44
13	142	8	150	3	4.53
TOTAL	**2261**	**2808**	**5068**	**100**	**21**
ESALS/LANE	**44.6**	**55.4**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Sep 2019	11850	400	95	9013	76.1	2836.7	23.9
Oct 2019	12833	418	106	9551	74.4	3281.7	25.6
Nov 2019	12077	411	112	8708	72.1	3369	27.9
TOTAL	**36760**	**–**	**–**	**27272**	**–**	**9487**	**–**
AVERAGE	**12253**	**410**	**104**	**9091**	**74**	**3162**	**26**

###ESALs

Month	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Sep 2019	1475	2380	3855	21.5
Oct 2019	1519	3137	4656	45.6
Nov 2019	2314	4841	7155	55.5
TOTAL	**5308**	**–**	**–**	**–**
AVERAGE	**1770**	**3452**	**5222**	**41**

###Gross Vehicle Weight

Month	*GVW NB Driving Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Sep 19	75928	98761	174689
Oct 19	90639	113500	204139
Nov 19	102355	106537	208892
TOTAL	**268921**	**318798**	**587720**
AVERAGE	**89640**	**106266**	**195906**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Sep 2019	1028	10.2	42.3	322	35
Oct 2019	1117	9.8	37.7	493	77
Nov 2019	1284	12.3	42.7	688	112
TOTAL	**3429**	**–**	**–**	**1503**	**224**
AVERAGE	**1143**	**10.8**	**40.9**	**501**	**74.7**

###Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Sep 2019	12950	19331	32281	40.1	59.9

Oct 2019	13361	23154	36515	36.6	63.4
Nov 2019	17656	22028	39684	44.5	55.5
TOTAL	**43967**	**64513**	**108480**	**–**	**–**
AVERAGE	**14655.7**	**21504.2**	**36159.9**	**40.4**	**59.6**